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Measurements of the absorption of methane at long paths and low temperature from observations on the Huygens Probe in the atmosphere of Titan

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Laboratory measurements of the absorption of methane for comparison with planetary spectra are hampered by the difficulty of matching the pressure and abundance of methane in a cell at the very cold temperatures prevailing on the outer planets. The Descent Imager/Spectral Radiometer (DISR) instrument on the Huygens Probe into Titan's atmosphere obtained spectra looking back toward the sun as it fell to successively lower altitudes from 150 km to the surface of Titan. These observations show the formation of methane absorption bands between 500 and 1600 nm as the probe fell to deeper levels. The methane mixing ratio at each level was measured by the Gas Chromatograph/Mass Spectrometer (GCMS) instrument on the probe. The haze structure has been determined from the probe observations in continuum spectral regions. Here we compare the DISR spectra with latest laboratory measurements at temperatures down to 100 K. We find that the methane absorptions in the strong bands show absorptions roughly half as strong as the laboratory measurements. We suppose that this is because the laboratory measurements are generally made at much higher pressures than the pressures where these strong bands form on Titan, and that the lines making up the bands are more saturated on Titan compared to the laboratory conditions. In the regions of weakest absorption, we find that Titan shows generally more absorption than the laboratory measurements which at 100 K are limited by condensation of methane in the cell at the pressures necessary to give easily measurable absorption. In these cases, the laboratory measurements at warmer temperatures have been extrapolated to colder temperatures. The DISR measurements suggest that this extrapolated results need to be increased significantly to produce agreement in the regions of weak absorption with the observations at the cold Titan temperatures.